

# The Coffee Bean Efficiency

## Team Four Constraints

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# Outline

- Objective
- Background
- Methodology
- Data & Analysis
  - Excel
  - Simul8
- Live Simulation (if we have time)
- Conclusion
- Questions

# Objectives

- To come up with an efficient optimized plan of worker schedule for coffee bean at any given time.
- Based on trends of how many people come, an optimal schedule will be suggested regarding how many servers should be working each shift to offer a reasonably satisfactory service to waiting customers.
- Determine measures of performance of waiting lines to help us in the design of the optimal schedule for The coffee Bean.



# Background

- Queueing theory occupies a prominent role in the performance analysis of a wide range of systems.
- Queueing Systems
  - Tool for modeling a system and analyzing performance
  - Quantify waiting lines using measures of performance



- Arrival of customers occurs randomly
  - Not influenced by the time that has elapsed since last customer

# Background

- Random interarrival and service times are described quantitatively in queuing models by the exponential distribution.
- The mean arrival rate (per unit of time) at each system is denoted by  $\lambda$  and it is the reciprocal of the average interarrival time.
- The parameter of the departure rate ( $\mu$ ) is expressed as the reciprocal of the mean service time.



# Background

## Kendall Notation ( a / b / c ) : ( d / e / f )

a	Arrivals Distribution
b	Departures Distribution
c	Number of Servers
d	Queue Discipline
e	Max System Capacity
f	Size of Calling Source

# Background

## Measures of Performance

$L_s$	Expected # of customers in system
$L_q$	Expected # of customers in queue
$W_s$	Expected wait time in system
$W_q$	Expected wait time in queue
$\bar{C}$	Expected number of busy servers
$\bar{C} / C$	Facility utilization

# Methodology

1. Chose a Coffee Bean location – Figueroa Street
2. Obtained corporate norms from store manager
3. Understood the three shifts and busy hours
  - Morning → 7-11 am (busy hours 7-10 am)
  - Mid-Day → 11-5 pm
  - Evening → 5-11pm
4. Took three one-hour samples (one at each shift)
  - measured arrival times and service times

# Methodology

5. Calculated measures of performance using ExcelStat Tabels
6. Simulated the system with “Simul8” several times by employing different number of servers for each of the three shifts
7. Came-up with optimized plans of number of workers for each shift

# Data & Analysis

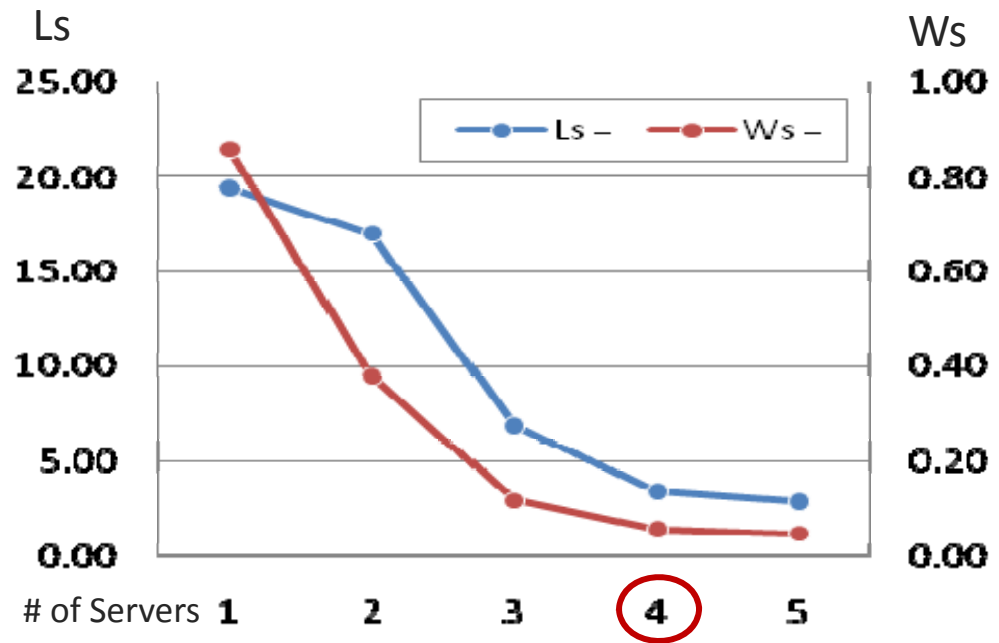
- Assumptions
  - Arrival and departure rates are based on poisson assumptions
  - Service ends when customers receive their orders
  - Customers will balk if queue extends outside of the store
  - The system capacity is 20 customers
- Facts
  - 4 servers at any shift
  - Queue discipline is First Come, First Served (FCFS)
- $(M/M/4) : (FCFS/20/\infty)$

# Data & Analysis



coffeebean  
analysis

	Morning
Date	Nov. 16 2010
Time	09:25 ~ 10:25 (1hr)
Total Customers	60
Servers (c)	4
Arrival rate ( $\lambda$ )	60 / hr
Service rate ( $\mu$ )	22.54



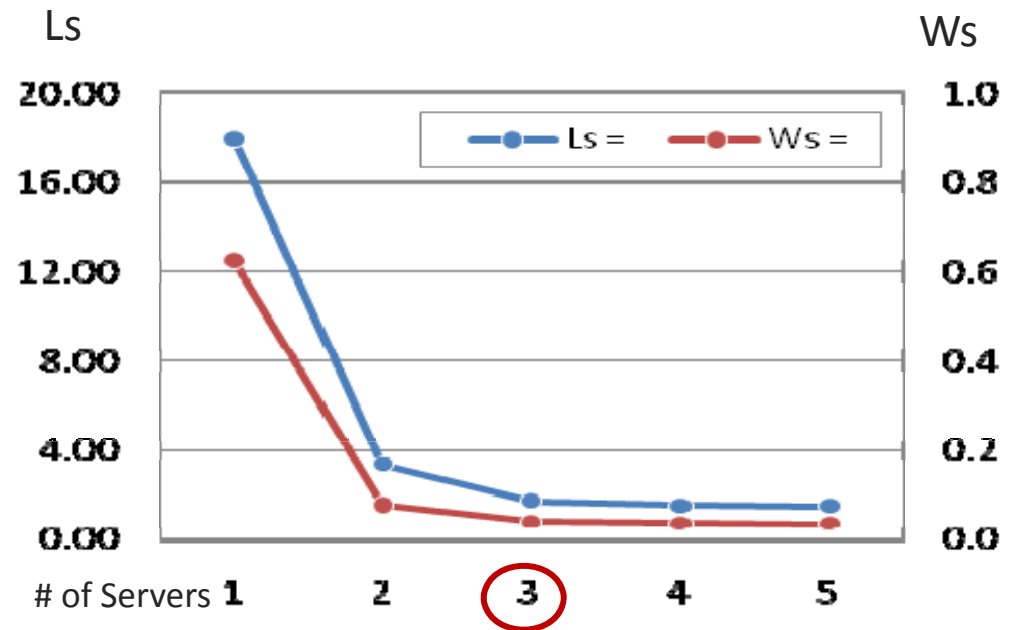
# of Servers	1	2	3	4	5
Ws (min)	51.64	22.70	6.98	3.40	2.84
$\bar{C} / C$	1100%	573.6%	161.9%	71.0%	53.7%

# Data & Analysis



coffeebean  
analysis

	Mid-Day
Date	Nov. 11 2010
Time	14:20 ~ 15:20 (1hr)
Total Customers	43
Servers (c)	4
Arrival rate ( $\lambda$ )	43.2 / hr
Service rate ( $\mu$ )	28.79



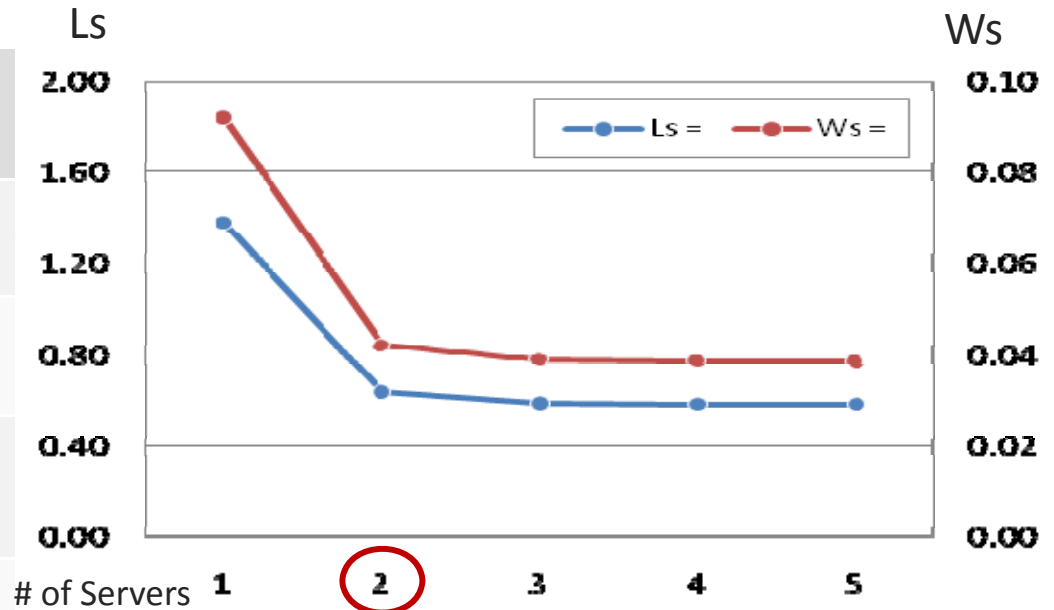
# of Servers	1	2	3	4	5
Ws (min)	37.47	4.64	2.41	2.15	2.10
$\bar{C} / C$	100.0%	74.6%	49.8%	37.3%	29.9%

# Data & Analysis



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Evening	
Date	Nov. 11 2010
Time	21:30 ~ 22:30 (1hr)
Total Customers	15
Servers (c)	4
Arrival rate ( $\lambda$ )	15 / hr
Service rate ( $\mu$ )	25.85

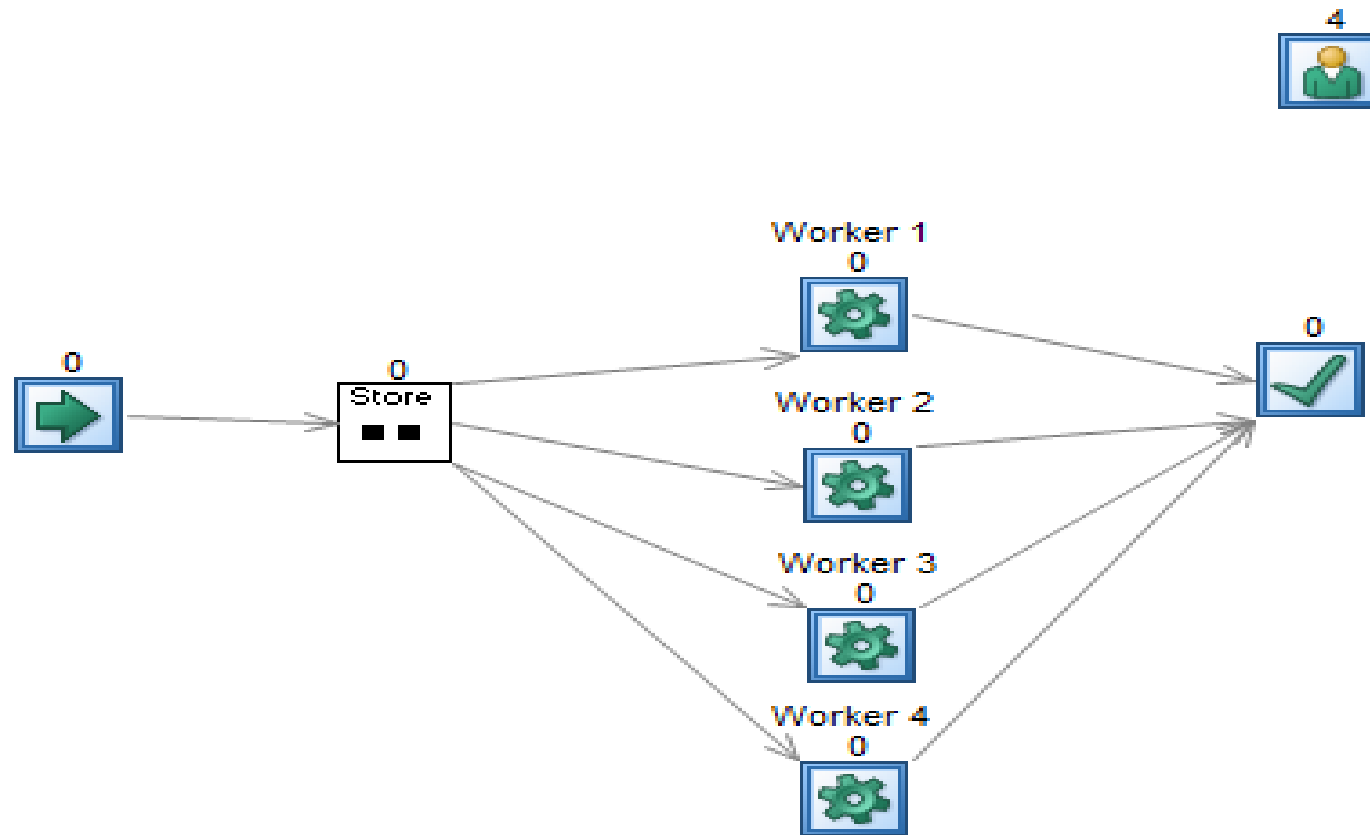


# of Servers	1	2	3	4	5
Ws (min)	5.53	2.53	2.34	2.32	2.32
$\bar{C}/C$	58.00%	29.01%	19.34%	14.51%	11.61%

# Data & Analysis

- Simulation with Simul8
- Simulate the current situation for each shift
- Simulate solutions for each shift
  
- The simulations ran for an hour
- Conduct 10 trials for each simulation
- Retrieve the results from the software

# Data & Analysis



Current System at Coffee Bean

# Data & Analysis

## Morning shift

- Simulation of current situation – 4 servers
- Simulation of two solutions – 3 and 5 servers

	4 Servers	5 Servers	3 Servers
Utilization rate	70.40%	55.00%	N/A
Waiting time in queue (Wq)	1.06 min	0.25 min	N/A
Customers in queue (Lq)	0.91 cust	0.32 cust	N/A
Average time in system	5.38 min	4.58 min	N/A

- With 3 servers – queue gets too long and customers balk!
- Optimal solution? 4 or 5 servers
  - Tradeoff between utilization rate and waiting time – depends on managers' preferences

# Data & Analysis

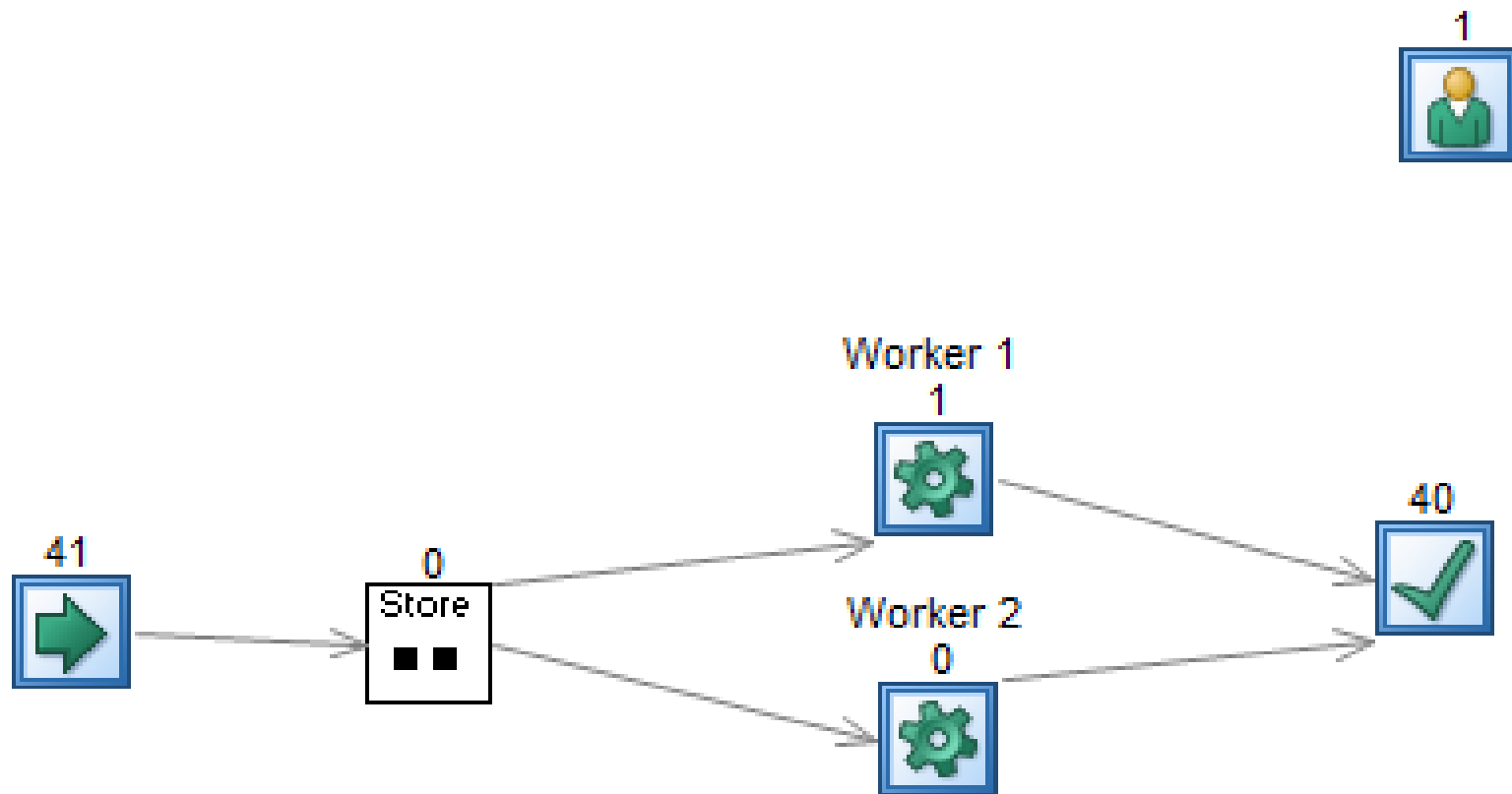
## Mid-Day shift

- Simulation of current situation – 4 servers
- Simulation of two solutions – 2 and 3 servers

	4 Servers	3 Servers	2 Servers
Utilization rate	38.28%	51.60%	73.33%
Waiting time in queue ( $W_q$ )	0.09 min	0.44 min	3.16 min
Customers in queue ( $L_q$ )	0.02 cust	0.42 cust	1.65 cust
Average time in system	3.75 min	3.98 min	5.51 min

- Optimal solution? 2 or 3 servers
  - Tradeoff between utilization rate and waiting time – depends on managers' preferences

# Data & Analysis



2 Server Simulation ~ Mid-Day Shift

# Data & Analysis

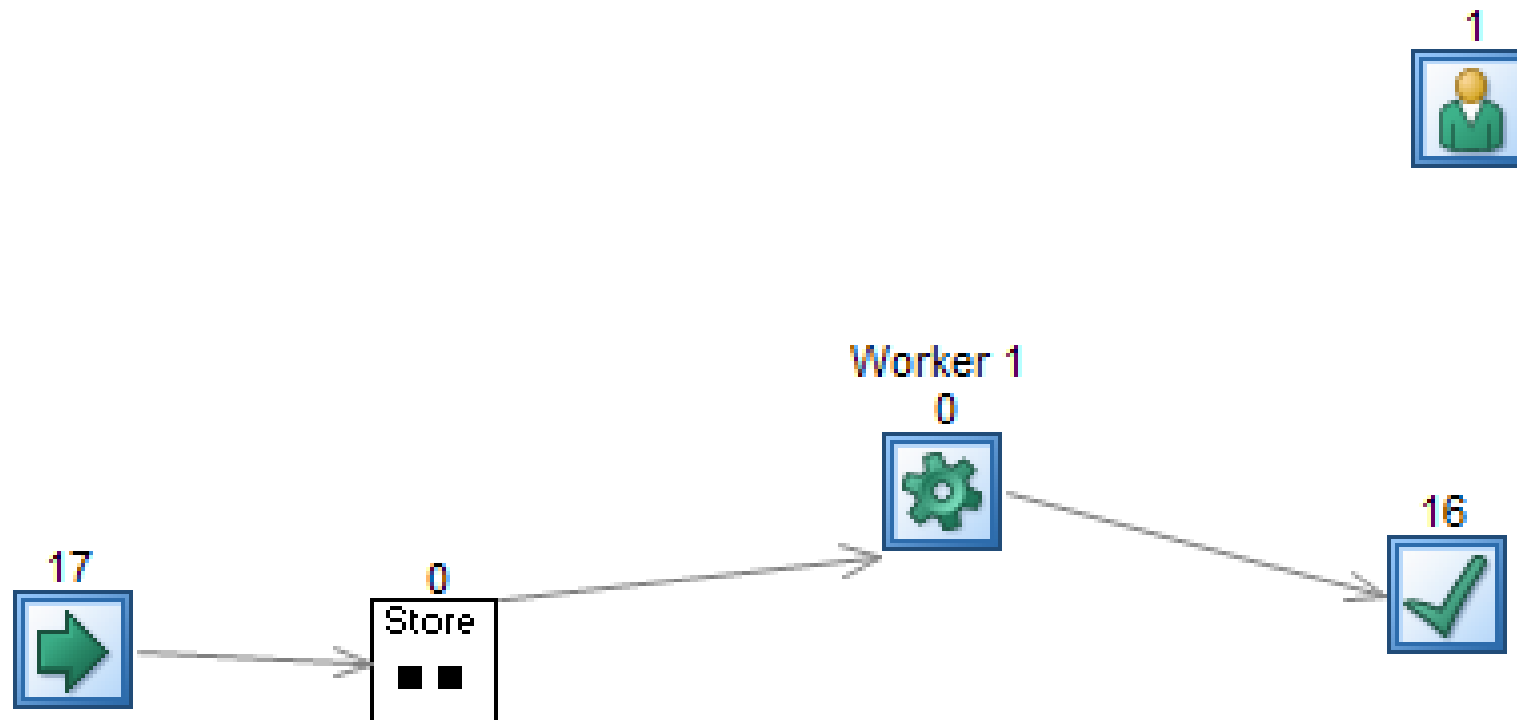
## Evening shift

- Simulation of current situation – 4 servers
- Simulation of three solutions – 1, 2 and 3 servers

	4 Servers	3 Servers	2 Servers	1 Server
Utilization rate	18.00%	23.80%	33.29%	69.46%
Waiting time in queue (Wq)	0 min	0 min	0.09 min	2.54 min
Customers in queue (Lq)	0 cust	0 cust	0.04 cust	0.62 cust
Average time in system	4 min	3.78 min	3.60 min	6.29 min

- Optimal solution? 1 or 2 servers
  - Tradeoff between utilization rate and waiting time – depends on managers' preferences
  - Might be inadequate to have only 1 server if something comes up
  - Servers on the evening/night shifts probably have more chores to do

# Data & Analysis



1 Server Simulation ~ Evening Shift

# Live Simulation

- Using Simul8 Software

# Conclusion

- Our recommendations:

	Morning	Mid-Day	Evening
Emphasis on utilization	4 servers	2 servers	1 server
Emphasis on waiting time	5 servers	3 servers	2 servers

- Other factors to consider:

- Avoid excessive utilization – servers need to have additional time to clean and do other chores
- Salary costs vs. revenue
- Facility – can it accommodate 5 servers at a time?
- Social factors – if they decide to have only one server on the evening/night shift

Questions?